PHYKOS
Phycological Society, India

First Report on the Cyanobacteria *Spirulina platensis* bloom and its effect on the physico-chemical parameters, at Muttukadu backwater, Southeast coast of India

Arulmoorthy, M.P. , S. Vasudevan*, V.Ashokprabu and M. Srinivasa

Centre of Advanced Study in Marine Biology,Annamalai University, Parangipettai – 608 502, Tamil Nadu, India
*Corresponding author:E. mail: vasubiology87@gmail.com

Abstract

Present study is the first registration of a bloom of the *Spirulina platensis* in the Muttukadu estuary, Tamilnadu, southeast coast of India. The plankton samples were collected from the Muttukadu estuary in during January 2014 to June-2014 in three stations by phytoplankton net. The water samples were collected in the sterilized plastic bottles for the analysis of physico-chemical parameters. We confirmed the presence of *Spirulina platensis* bloom in Muttukadu estuary. The density of *Spirulina platensis* was reported an average of $4.1x10^7$, $5.5x10^7$ and $4.7x10^7$cells/1 respectively. The pH ranged between 7.11 and 8.42 in all three stations. The dissolved oxygen ranged from 4.19 to7.54 ml/l and salinity between 1.02 and 7.32 ppt. Silicate and nitrate levels were very high when compared to other nutrients. Muttukadu estuary is highly polluted due to discharges from the households, industries and tourism activity carried out on the bank of the Muttukadu backwater. This study showed the presence of *Spirulinaplatensis* bloom in the Muttukadu backwater.

Keywords: Muttukadu, Bloom, *Spirulina Platensis*, Nutrients, Phytoplankton

Introduction

Occurrence of cyanobacterial blooms is a worldwide phenomenon affecting the aquatic ecosystem (Sivonen1996). *Spirulina* bloom typically thrives in the warm, turbid and slow moving waters. Blooms with the highest biomass occur in waters rich in nitrogen and phosphorous. The southeast coast of India is an important stretch of coastline, where many major rivers consume into the Bay of Bengal and they are also more affluent in marine fauna and flora (Rajkumar *et al.* 2011). Muttukadu backwater form a complex ecosystem of shallow estuarine network spread over an area of 217.98 acres (87.190 hectares) meant for fishing and boating activities. The backwater extends to north and southwards for about 15 Km and opens into the Bay of Bengal at its eastern end. The bar mouth acts as a barrier and the sea water infiltrates into the land which is the majorresource for the prawn hatcheries mostly situated in this area (Bharathi and Ramanibai 2012). Estuaries, the majorcontributor of fisheries in India suffer from severe damage which receive large amount of contaminants due to enlarged industrialization and urbanization along the coastal areas by continuous discharge of domestic sewage and industrial effluents. Muttukadu backwaters are highly polluted by the household and industrial discharges. Overfilling of the estuaries with contaminants for a longer period of time has resulted in the significant buildup of pollutants with a resulting impact on water quality (Padmini *et al.* 2004). Santhanam *et al*.(2014), reported the first intensive *Microsystis aeruginosa* bloom in Muttukadu backwaters. Paramisivam and Kannan 2005) reported that factors similar to water quality such as temperature, pH, salinity, dissolved oxygen, total organic carbon and nutrients are particularly essential for determining the biota and ecosystem functions in coastal waters. Several reports are available on the occurrence of algal bloom in marine and brackish waters (Prescott 1954; Selvakumar and Sundararaman 2007; Reginald 2007; Velankar and Chaugule 2007). This paper documents the first occurrence of an algal bloom of *Spirulina platensis*i n Muttukadu backwater, southeast coast of India.

Materials and Methods:

Description of the study area

Muttukadu backwater (near south ChennaiTamil Nadu) (Lat. 12^0 49' N; Long. 80^0 15' E) extends for a distance of 20 km from the mouth of the estuary as shown in Figure. 1. The backwater runs at right angle to the coast for a distance of about 3 km and branches into southern and northern wings. The backwater is connected to the sea by a bar built mouth, the width of which is variable from a few meters to 200 m in different months. The backwater is normally cut off from the monsoon period and rest of the period sand bar is formed due to inundation by the fresh water from the upper reaches, the sand bar gets eroded and the connection with the sea is restored.

Figure 1.Map showing the study area Muttukadu

Collection of Plankton

Surface water was green with floating layers of green scum as shown in Figure. 2. Plankton samples were collected using a Plankton net. The plankton net is made up of bolting silk cloth no 30, mesh size 48 µm and mouth diameter of 0.35 m. the net is submerged in the surface water and towed horizontally from a mechanized boat with an outboard engine at a speed of 01 – 02 knots/hour. The collected plankton samples were fixed with 5% formaldehyde solution in the field itself. For the identification of species, 1-2 drops of sample were put on a slide, covered with a cover glass and examined under light microscope followed by the method (Subrahmanyan1946; Venkataraman 1939; Steidinger 1970). Eukaryotic phytoplankton cell counter were performed on Sedgewick- rafter counting slide (Guillard 1978).

Figure 2. Current status of Cyanobacterial *Spirulina* algal bloom of Muttukadu water

Analysis of water samples for physico-chemical properties

The temperature was measured using a standard Celsius Thermometer. Salinity was estimated with the help of a Hand Refractrometer. pH was measured by the ELICO grip pH meter. Dissolved Oxygen (DO) was estimated by the Winkler's method. Water samples were collected in clean polyethylene bottles, which were kept immediately in an ice box and then transported to the laboratory for the analysis of nutrients. The collected water samples were filtered using a Millipore Vacuum Filtration system and analyzed for dissolved inorganic nitrate, nitrite, phosphate, reactive silicate and ammonia by adapting the standard methods described by (Strickland and Parsons 1972).

Results

Spirulina platensis bloom was observed in the water samples as shown in Figure. 3. *Spirulina platensis*was dominated 98% of the total phytoplankton density during bloom (Figure. 4). *Spirulina platensis* blooms were recorded in following months are January, February, March, April, May and June-2013 (Figure.5). During the study period, in station-I, the *Spirulina platensis* cell density values varied between $4.1x10^7$ Cells/L to $2.7x10^7$ Cells/L. The Highest cell density of *Spirulina platensis* was recorded during the summer season (May) and the lowest cell density of *Spirulina platensis*was recorded during Post-monsoon season (February). In station-II, the *Spirulina platensis* cell density was varied between $5.5x10^7$ Cells/1 to $2.3x10^7$ Cells/L. Highest cell density was recorded during the summer season (May) and the lowest cell density was recorded during Post-monsoon (March). In station-III, *Spirulina platensis* cell density was varied between $4.7x10^7$ Cells/1 to $2.1x10^7$ Cells/L. Highest cell density was recorded during the summer season (May) and the lowest cell density were recorded during Post-monsoon (February)Physico-chemical variables were measured from surface water during the bloom occurrence were given in the Figure. 6,7,8. Water in this region was green colored, slimy in nature with foul smell as shown in Figure. 9 and 10.This coloration in Muttukadu backwater was established due to the presence of large concentration of *Spirulinaplatensis* bloom. The *Spirulina* bloom normally decreases the dissolved oxygen concentration of the water. The oxygen deficiency could leads to the fish mortality.

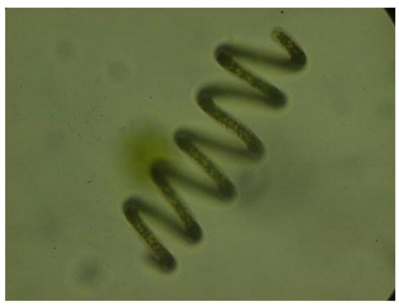

Fig 3 Fig 4

Figure 3. Bloom forming cyanobacteria *Spirulina platensis* Figure 4. High density of Bloom forming cyanobacteria *Spirulina platensis*

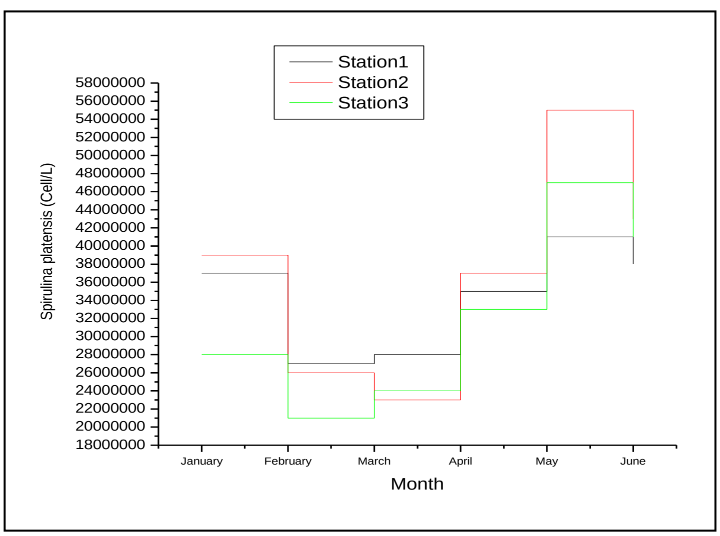

Figure 5. *Spirulina platensis* bloom cell density variation of Muttukadu backwater

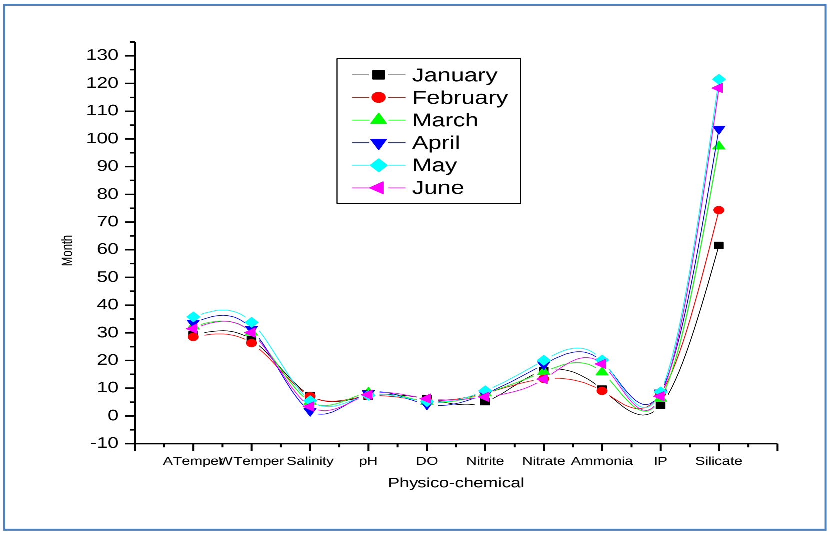

Figure 6: During Study period the Physico-Chemical Parameter in the Muttukadu Backwater in Station-1

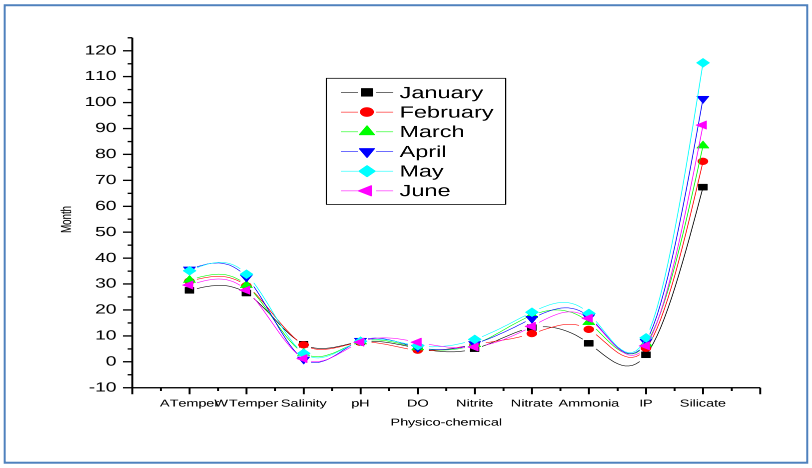

Figure 7: During Study period the Physico-Chemical Parameter in the Muttukadu Backwater in Station-2

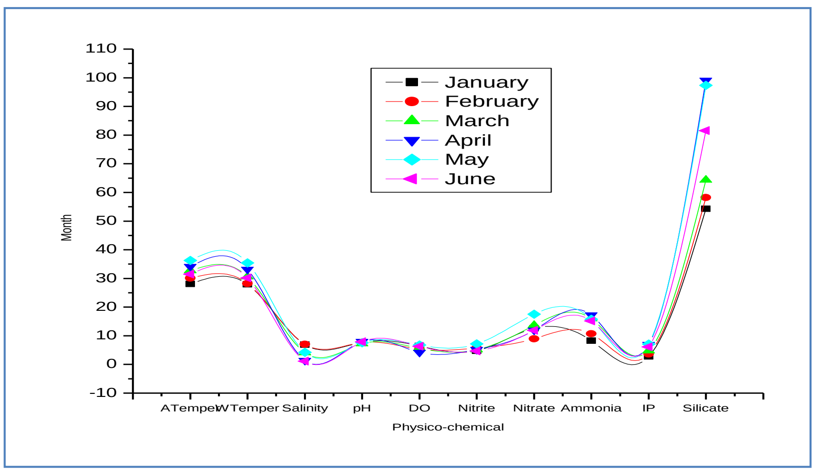

Figure 8: During Study period the Physico-Chemical Parameter in the Muttukadu Backwater in Station-3

Figure 9. Slimy green layer of Muttukadu backwater

Figure 10. Biomass of Cyanobacterial algal bloom

Atmospheric temperature was varied from 36.3°C to 27.5°C A minimum (27.5°C) and maximum (36.3) was recorded in all three stations in January and May respectively. Surface water temperature was varied from 35.4°C to 26.5°C A minimum (26.5°C) and maximum (35.4°C) was recorded in station-3 and station 2 in the months of January and May respectively

Salinity varied from1.02 to 7.32 ppt. highest salinity of to 7.32 ppt was observed in station 1 during the month of January and the lowest 1.02 ppt was observed in station 2 during the month of April in all the three station The highest value of pH was8.42 at station 1 was recorded in the month of January and the lowest 7.11 at station 1 was recorded in the month of March. During the study period DO values varied between 4.19mg L-^{1} to 7.54 mg L-$^{1.}$ Highest DO was recorded at station 2 in the month of June and the lowest was recorded at station 1 in the Nitrite- N was varied from 9.11μ mol L^{-1}to 4.65 μ mol L^{-1}. Maximum was recorded in station-1(9.11μ mol L^{-1}) in the month of May. Minimum was recorded in station-3 (4.65μ mol L^{-1}) in the month of June. Nitrate - N was recorded from 20.11 to 8.95. Maximum 20.11 was observed in station-1 in the months of May. Minimum 8.95 was recorded in station-3 in the month of February. Phosphate- P was varied from 9.23μ mol L^{-1} to 2.65μ mol L^{-1}. Maximum was recorded in station-2 (9.23μ mol L^{-1}) in the month of May. Minimum was recorded in station-2 (2.65μ mol L^{-1}) in the month of January. Silicate was varied from 121.54μ mol L^{-1}to 54.26 μ mol L^{-1}. Maximum was recorded in station-1 (121.54μ mol L^{-1}) in the month of May. Minimum was recorded in station-3 (54.26μ mol L^{-1}) in the month of January. Ammonia was recorded from 20.15 to7.14 μ mol L^{-1}. Maximum was recorded in station-1 (20.15μ mol L^{-1}) in the month of May. Minimum was recorded at station-2 (7.14μ mol L^{-1}) in the month of January.

Discussion

High level of urbanization and large amount of discharges from domestic and factories located along the bank of Muttukadu estuary affects the water quality of the Muttukadu backwater. Due to this, high level of nutrients accelerates the eutrophication process of this region. The nutrient concentration in surface water receiving high solar radiation can influence the abundance of phytoplankton. This is increase the phosphorous content of the surface water. This could be the reason for a bloom of the cyanobacterium *Spirulina platensis* during this period as proposed by earlier works (Yoshinaga 2006). In this present investigation, the *Spirulina* bloom was observed when the temperature was higher; this is supported by (Murrell &Lores 2004) who stated cyanobacteria dominance often occurs when temperature rises above 20^{0}C. This pattern also occurs in subtropical waters, including coastal. During daylight hours the photosynthesis activities of the micro algae produces high level of oxygen of the highly dense algal bloom respiration. Thus the Dissolved oxygen concentrate was found to higher during the active bloom day. Salinity has been found to be another important factor influencing the cyanobacterial bloom (Blackburn 1996; Hobson 1999), although many species are also capable of grow and bloom over a wide range of salinities (Reed & Stewart, 1988). A standard Secchi Disc was used to determine water transparency. *Spirulina* bloom reduced water transparency through highly dense algal biomass. In this present study, inorganic nutrients, especially nitrate and phosphate, are key indicators of water quality in aquatic environment. Nitrate is highly soluble and leaches readily from the soil and when nitrate is readily available in waterways it can contribute to harmful algal bloom. Phosphate concentration also high in bloom days it may be due to the decomposition by microbial process as reported earlier (Raghuprasad and Jayaraman 1954; SubbaRao 1969; Sahayak *et al.* 2005). On the day of highest cell density, ammonia concentration was high which might be due to the high demineralization ability of Cyanobacteria to produce ammonia through the process of nitrogen fixation (Chang *et al*. 2000). Due to the presence of high ammonia or oxygen deficiency may result in fish mortality. The excessive nutrient load can cause rapid growth of algal populations called bloom, when we can easily see patches of algae in the water. Since the Muttukadu estuary is a bar built one, no seawater inundation has been recorded during the bloom time due to the bar mouth closing. In the present study, station-I got intensive bloom when compared to Station-II and Station-III during the Present study. This is because, the domestic and industrial sewages are routinely get discharged near to station-I and also the waters of Station-II and III get connected in Station-I. High level of nutrient loads naturally enhances the over-growth of Cyanobacteria to form bloom.It is well known that the stagnant condition resulting lack of flow of water and high level domestic and industrial discharges might have supported large density of *Spirulina platensis* which occupied around 98% of the biomass. Muttukadu backwater must be monitored regularly for biodiversity conservation and human health concern.

Acknowledgement

The Authors are thankful to MHRD for their financial support. The authors also thank the authorities of Annamalai University for their support and encouragement.

References

1. *Sivonen* K. 1996.Cyanobacterial toxins and toxin production. *Phycologia.,* 35: 12–24 .
2. Rajkumar JSI, John Milton MC, AmbroseT. 2011. Seasonal variation of water quality parameters in Ennore estuary with respect to industrial and domestic sewage. *Int. J. of Cur. Res.,* 33 (3) : 209–218.
3. BharathiDevi NS,Ramanibai R. 2012.Distribution and abundance of zooplankton in Muttukadu backwater, Chennai.*J. of Res. in Bio.,* 2 (1) : 35–41.

4. Padmini E, ThendralHepsibha B,ShanthalinShellomith AS. 2004. Lipid alteration as stress markers in grey mullets (*Mugilcephalus*Linnaeus) caused by industrial effluents in Ennore estuary (oxidative stress in fish). *Aquaculture.,* 5 : 115–118.
5.Balaji Prasath B, Nandakumar R, Jayalakshmi T,Santhanam P. 2014. First report on the intensive cyanobacteria *Microcystisaeruginosa*Kutzing, 1846 bloom at Muttukadu Backwater, Southeast coast of India.*Indian journal of Geo-Marine Sciences.,* 43(2) : 258-261.
6. Paramasivam, S, KannanL. 2005.Physico-chemical characteristics of Muthupettai mangrove environment, Southeast coast of India.*Int. J. Ecol. Environ. Sci.,*31 : 273–278.
7. Thajuddin N, Nagasathya A,ChelladeviR, Saravanan I. 2002. Biodiversity of Cyanobacteria in different salt pans of pudukkotai District, Tamilnadu. *Seaweed research and utilization.,* 24 : 1-11.
8. Selvakumar K, Sundararaman M. 2007.Diversity of Cyanobacterial floral in the backwaters of palk bay region.*Seaweed research and utilization.,*29 : 139- 144.
9. Reginald M. 2007.studies on the importance of micro algae in solar salt production. *Seaweed research and utilization.,* 29 : 151- 184.
10. Velankar AD,ChauguleBB. 2007. Algae of the salt pans of Nalasopara, Mumbai. *Seaweed research and utilization.,* 29 : 273- 278.
11. Subrahmanyan R. 1946. The diatoms of the Madras coast.*Proc. Indian, Acad. Sci.,* 24 : 85-197.
12. Venkataraman G. 1939.A systematic account of some South Indian.*Proc*. *Indian Acad*. *Sci*., 10 : 293-368.
13. SteidingerKA 1970. Williams, E.,Dinoflagellates.*Memory Hourglass Cruises.,* 2 : 1-251.
14. Prescott GW, 1954. How to Know the Freshwater Algae. W.M.C. Brown Company, Iowa., pp. 272.
15. Guillard RRL. 1978. Counting slides. In Sournia,A. (ed.), *Phytoplankton Manual-Monographs on Oceanographic Methodology*. *UNESCO,* Paris, France.
16. Strickland J D H, Parsons TR. 1972.A practical hand book of seawater analysis.*Fish*.*Res*. *Board Can*. *Bull*., 167 : 185-199.
17. Yoshinaga I,HitomiT, Miura A,Shiratani E, MiyazakiT. 2006.Cyanobacteriummicrocystis bloom in a Eutrophicated regulating reservoir. *JARQ.,* 40(3) : 283-289.
18. Murrell MC, Lores EM. 2004.phytoplankton and zooplankton seasonal dynamics in a subtropical estuary: importance of cyanobacteria. *Journal of plankton research.,* 26 : 71-382.
19. Blackburn SI,McCausland MA, Bolch CJS, NewmanSJ, Jones GJ. 1996. Effect of salinity on growth and toxin production in cultures of the bloom forming cyanobacterium*Nodulariaspumigera* from Australian waters. *Phycologia.,* 36(6) : 511-522.
20. Hobson P, Burch M, Fallowfield HJ. 1999. Effect of total dissolved solids and irradiance on growth and toxin production by *Nodulariaspumigera*. *J.Appl. phycol.,*11 : 551-558.
21. Reed RH, Stewart WDP. 1988. The responses of cyanobacteria to salt stress. In: Biochemistry of the algae and cyanobacteria. L.J. Rogers & J.R. Gallon (eds)., 1988, 217 – 231. Clarendron Press, Oxford.
22. SubbaRao SDV. 1969.Asterionella japonica bloom and discolouiration off Waltair, Bay of Bengal. Limnol.Oceanogr., 14 : 632-634.
23. Raghuprasad R, Jayaraman R. 1954. Preliminary studies on certain changes in the plankton and hydrological conditions associated with the swarming ofNoctiluca. *Proc.ind.Acad.Sci.,* 40 : 49-57.
24. Sahayak S, Jyothibabu R,Jayalakshmi KJ,Habeebrehman H, Sabu P,Prabhakaran MP, Jasmine P,Shaiju P,Rejomon G, Thressiamma J, Nair KKC. 2005. Thiruvananthapuram subsequent to be “ stench event” at the south Kerala coast. *curr.sci.,* 89 : 1472-1473.
25. Chang J, Chiang KP,Gong GC. 2000. Seasonal variation and cross- shelf distribution of the nitrogen – fixing cyanobacteria, trichodesmium, in southern east china sea. *Cont. shelf Res.,*20 :479-492.